

Introduction

Preliminary findings:

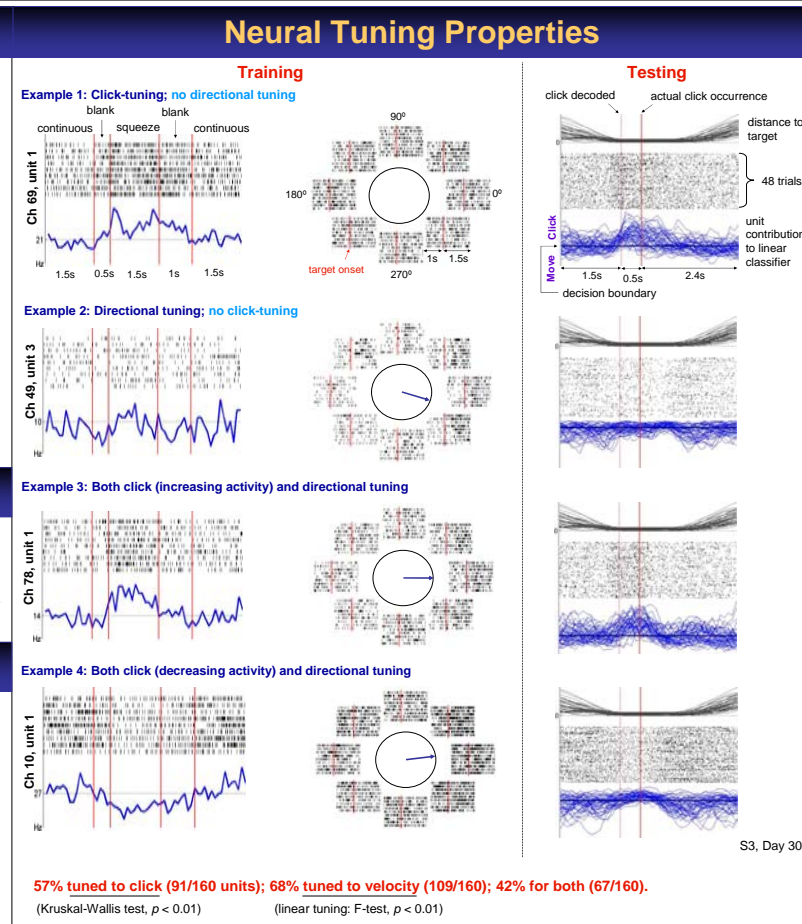
- Movement-related signals in MI of humans can be detected, modulated and decoded for controlling external devices¹
- Decoding cursor velocity using the Kalman filter improved neural cursor control²
- Both continuous (kinematics) and discrete (attention) states could be decoded from the MI population of a monkey³

Challenges:

- Utility of **click** is required for practical cursor use.
- Can we simultaneously decode **continuous** and **discrete** states from a single neural population ($n < 100$) in a human?
- How to **train** both the user and the decoding algorithm on-line without observation of true kinematics, especially for **click**?
- How to **assess** cursor control performance?

Objective:

- Enable humans with tetraplegia to point and click a computer cursor at any location on screen, then to move the cursor again and click at another location.



Quantification

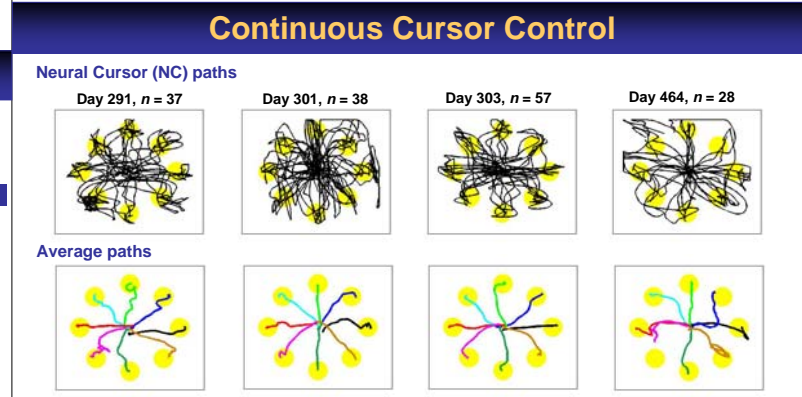
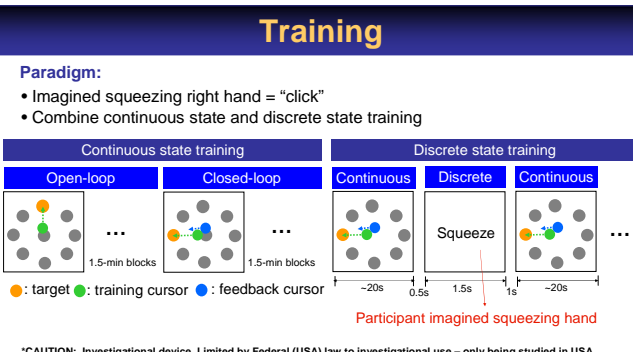
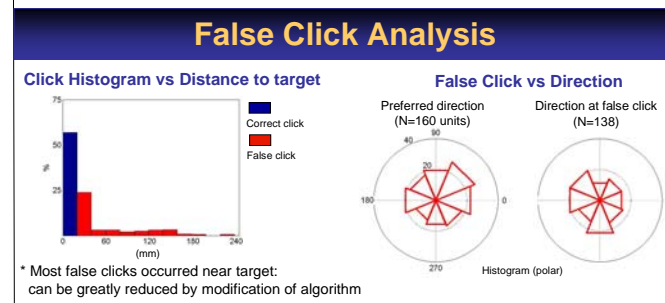
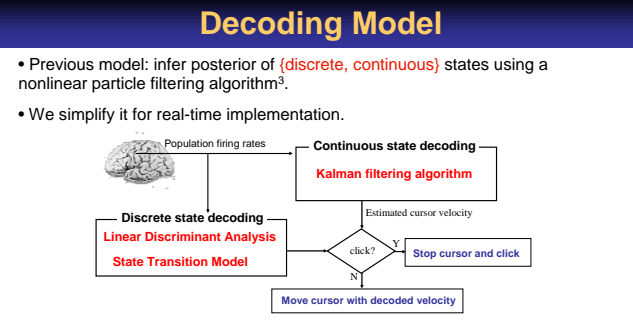
- Performance was measured for the 8-target acquisition task (10 min)
- Utilize pointing device assessment measures in human-computer interaction (HCI) (ISO 9241-9; Douglas *et al.* 1999⁴; MacKenzie *et al.* 2001⁵; See poster 517.16)

ER-to: Error Rate due to timeout
ER-fs: Error Rate due to false target selection
MT: Mean Movement Time
ODC: Orthogonal Direction Change
MDC: Movement Direction Change
ME: Movement Error
MV: Movement Variability
FCR: False Click Rate per trial

Day	# Units	# Trials	Timeout	ER-to	ER-fs	MT	ODC	MDC	ME (mm)	MV (mm)	FCR
291	37	41	30s	0%	0%	8.7s	3.9	6.7	15.5	15.2	0.78
301	38	68	30s	0%	0%	6.8s	1.8	4.5	15.7	14.3	0.94
303	57	51	9s	3.9%	0%	6.2s	1.8	4.1	13.5	13.1	0.29
464	28	33	15s	9.1%	0%	7.7s	2.4	4.6	23.7	19.9	0.97
Avg.	40			2.6%	0%	7.2s	2.3	4.9	16.4	15.1	0.74

Recording

- 53-yr-old Female (S3) enrolled in the BrainGate™ pilot study (IDE)*
- Brainstem stroke – 9 years before enrollment
- CYKN array was implanted in the MI arm area in Nov. 2005
- Array has been implanted and neural signals were recorded for ~2yrs
- Study recording days: 292 ($n=37$), 301 ($n=38$), 303 ($n=57$) and 464 ($n=28$)



Conclusions

- Demonstrated feasibility of **point-and-click** cursor control in humans with tetraplegia
 - Decode **multi-state** signals from a single neural population of a human.
 - Develop a **training paradigm** for point-and-click control.
 - Improve the **usability** of the neural interface system.
- Current work
 - Improve multi-state decoding model (full joint state).
 - Decoding more discrete states (e.g. rest, back, ...).
- See Simeral *et al.* (SFN 517.16) for continuous, full-screen point-and-click.

References:

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